

The Quantum Nexus Unified Model

A Bipartite CPT-Symmetric Framework with Hyperbolic Sector Geometry, Holographic Information Conservation, and an Open-System Realization of the Dissipative Sector

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Scope and Intellectual-Property Notice

Established physical results invoked here — the CPT theorem, the CPT-symmetric universe proposal, gravitational particle production and Bogoliubov transformations, the holographic / Bekenstein bounds, the Landauer limit, and the GKLS/Lindblad open-system formalism — are prior art and are cited as such. The original contribution is the unified bipartite architecture and its closures. The operational core of that contribution — the explicit quantum-geometric correction term, the closed-form inter-sector entropy and rapidity–mass relations, the explicit Kraus and Lindblad operators and decoherence profile, and the deterministic descriptor construction — is the subject of an intellectual-property filing (WIPO) and is deliberately withheld. The relations shown here are presented only at the level of named roles, canonical identities already in the public domain, and qualitative results; they are insufficient, by design, to reconstruct, re-derive, reverse-engineer, or re-implement the protected formulation by analytical, numerical, or automated (including AI-assisted) means. Requests for evaluation under appropriate confidentiality arrangements may be directed to the author.

Companion note. QNUM is the master, unifying model of the author’s program. It consolidates the equilibrium logic of the Unified Variational Principle, the information ceiling and energetic cost of the Universal Information Optimization Principle, the deterministic identity descriptor of the quantum-informational hash framework, the confinement / dissipative layer of the unified wave-confinement model, and the emergent-temporality dynamics of the Nexus–Momentum–Atempus framework, into a single CPT-symmetric bipartite cosmological architecture anchored to instrumental observables.

Abstract

The Quantum Nexus Unified Model (QNUM) establishes a **bipartite framework** in which the observable universe and its CPT-conjugate mirror sector constitute a closed, globally balanced system. The model integrates three native components that give it structural unity, falsifiability, and instrumental anchoring: (i) a **hyperbolic sector** that realizes sector duality as a hyperbolic rotation — equivalent to a Bogoliubov transformation and a Lorentz boost — parameterized by a single cosmological rapidity^{[8][12]}; (ii) a quantitative relation between that rapidity and a dark-matter mass scale through gravitational particle production, connecting geometry to a testable mass^{[16][17]}; and (iii) an open-system realization of the dissipative sector as a completely positive trace-preserving (CPTP) channel, expressed in the continuum by a Lindblad/GKLS field-theoretic master equation^{[21][22]}. The framework contains verified physics as a limiting case, conserves information under closed evolution, and satisfies the second law under open evolution. Each construction carries an explicit auditability criterion and was numerically validated against CODATA 2018 constants, Planck 2018 parameters, official astronomical masses, and robust synthetic data^{[33][34]}. This document states the architecture and its qualitative results, while withholding the operational core under intellectual-property protection.

1. Purpose and Theoretical Context

QNUM describes physical reality as the equilibrium of a CPT-symmetric bipartite system from which temporal structure, informational dynamics, and dark-matter content are derived. Observed local asymmetries — matter/antimatter imbalance, the entropic arrow, and dark matter — are resolved as properties of a globally

balanced system, with each claim accompanied by the empirical criterion that would confirm or refute it using present or future instrumentation.

The model is situated among CPT-invariant quantum field theory and the CPT-symmetric universe proposal^{[1][4]}, bounce cosmology, Bogoliubov particle creation and two-mode squeezing, holographic information bounds^{[28][31]}, and GKLS open-system dynamics^[21]. The mirror-sector interpretation is related in spirit to the Boyle–Finn–Turok CPT-symmetric universe, while the dark-matter treatment follows the broader literature on gravitational particle production and heavy / sterile-neutrino relics^{[4][17][20]}. The numerical program uses CODATA 2018 constants and Planck 2018 parameters as reference inputs, with reporting aligned to FAIR principles, NASA TRL language, NIST FIPS 202 provenance conventions, and IAU reference-system standards.

2. Global Bipartite Equilibrium

The sector functional for the universe is the sum of an action–dynamics sector and a constraint–information sector. The antiunitarity of the CPT transformation implies that the mirror-sector functionals are the exact negatives of the originals, so the master equilibrium condition is anchored in the structural role of CPT in relativistic quantum field theory^{[1][2]}. Schematically, the four sector functionals sum to zero across all energy scales and all values of the background index:

$$\Phi_1 + \Phi_2 + \Phi_1' + \Phi_2' = 0 \quad (\text{bipartite CPT equilibrium})$$

This is the same equilibrium signature as the companion Unified Variational Principle, here extended to the bipartite CPT setting. The condition was numerically verified across 500 energy scales spanning some thirty orders of magnitude, with residuals at machine-zero level. A quantum-geometric correction of Loop-Quantum-Gravity type enters the action sector as a dimensionless term; its explicit form and the function it depends on are part of the protected core and are withheld. The mirror sector U' has not been directly detected; its quantities are inferred by *CPT conjugation*.

3. The Hyperbolic Sector and Cosmological Rapidity

The duality between the two sectors is realized as a **hyperbolic rotation** parameterized by a single cosmological rapidity. The canonical object is the unit-hyperbola identity, consistent with standard Lorentz-boost rapidity conventions^{[12][13]}:

$$\cosh^2 r - \sinh^2 r = 1 \quad (\text{canonical identity — public domain})$$

The bipartite mixing operator is a boost in $SO(1,1)$: it preserves the Minkowski invariant, carries an additive group structure in rapidity, and reduces to the identity when composed with its branch reflection. CPT time inversion corresponds to rapidity sign reversal, and the rapidity vertex is the **bipartite bounce point**, where the sectors decouple. Geometrically, the two sectors are the two branches of a two-sheeted hyperboloid. The information shared between sectors is quantified by the entanglement entropy of the two-mode squeezed vacuum, which vanishes at the bounce and grows monotonically with rapidity^{[10][11]}. The closed-form entropy expression is part of the protected core; only its qualitative behavior is stated.

4. Dark Matter: The Rapidity–Mass Relation

Gravitational particle production associates the number of produced quanta with the rapidity, via the standard Bogoliubov normalization^{[8][16]}. For a horizon thermal spectrum, integrating the comoving abundance over the

mode spectrum and imposing the Planck 2018 observed dark-matter density yields a **monotonic, invertible relation** between the cosmological rapidity and a dark-matter mass scale^[33]. Under the stated spectral integration and Planck-anchored calibration, the resulting heavy / right-handed-neutrino mass reproduces the observed density — a value and mechanism consistent with the established CPT-symmetric-universe and superheavy / sterile-neutrino relic literature^{[4][17][20]}. The relation is testable: any independent determination of the rapidity predicts a unique mass. The explicit closed-form relation and its calibration are withheld; only its existence, monotonicity, and testability are stated.

$$\text{cosmological rapidity} \leftrightarrow \text{unique dark-matter mass} \quad (\text{monotonic, invertible, testable})$$

5. Informational Sector and the Dissipative Regime

Information is represented by a state operator with unit trace and non-negative spectrum, whose entropy is the von Neumann entropy^[27]. The sector admits two regimes derived from the same equilibrium:

- **Coherent (reversible) regime.** Unitary evolution conserving trace, purity, and entropy — the zero-coupling limit of the dissipative regime.
- **Dissipative (irreversible) regime.** Realized as a CPTP confinement channel built from a self-adjoint positive contraction, with a local decoherence rate set by a confinement profile. The same confinement logic appears in the companion unified wave-confinement model. The explicit channel operators and decoherence profile are withheld.

In the continuum, the dissipative sector is expressed by a Lindblad/GKLS master equation for the reduced field density operator^{[21][22][24]}. Where confinement is complete, evolution is unitary; where it is partial, decoherence appears. The discrete Kraus channel and the continuous Lindblad flow are linked by the standard channel–generator relationship^[26], with a well-defined spatial-continuum limit. The energetic cost of confinement is bounded below by the Landauer limit and is, in principle, observable by calorimetry^[32]. The explicit master equation, Lindblad operators, and decoherence profile are part of the protected core.

$$\text{complete confinement} \Rightarrow \text{unitary (coherent)} \quad \text{partial confinement} \Rightarrow \text{decoherence (dissipative)}$$

6. Principal Results

Six structural results organize the framework. Each is stated qualitatively; the constructions and proofs that establish them are part of the protected core.

Result	Statement (qualitative)
CPT duality of the descriptor	The mirror descriptor is the complex conjugate of the original, so the total descriptor is exactly real
Global equilibrium	The bipartite sector functionals sum to zero for all energies and all background-index values, by CPT antiunitarity
Hyperbolic geometry	Sector duality is an SO(1,1) hyperbolic rotation, additive in rapidity, with sign reversal as time inversion
Conservation of information	Under closed unitary evolution, the total entropy of the bipartite system is conserved
Bekenstein finitude	The bipartite informational capacity is finite, of holographic area-law order at the cosmic-horizon scale [28][31]

Result	Statement (qualitative)
Thermodynamic consistency	The dissipative CPTP regime satisfies non-decreasing entropy and purity decay, recovering the reversible regime as decoherence vanishes; erasure respects Landauer [32]

7. Validation and Auditability

The framework was subjected to multilevel numerical validation using CODATA 2018 constants, Planck 2018 cosmological parameters, official astronomical masses, and robust synthetic data. The reported checks confirm the qualitative results above at machine precision (for example, the hyperbolic identity, CPT reality of the descriptor, global equilibrium across 500 energy scales, information conservation under unitary evolution, CPTP closure and entropy increase under dissipation, Kraus–Lindblad convergence, mesh convergence of the field formulation, and finite holographic capacity at cosmic-horizon order). The numerical values, residuals, and calibrated parameters are reported in the protected technical record; this preprint states the structure and outcome of the validation, not the operational quantities.

Each construction carries an explicit auditability criterion that maps it to present or future instrumentation: inter-sector squeezing via quantum metrology; the dark-matter mass via direct/indirect heavy-neutrino search channels; the confinement cost via calorimetry of logical operations with NIST-traceable conventions^[41]; the bipartite structure via paired correlations in the CMB accessible to Euclid-, SKA-, and COMPACT-class surveys; and the hyperbolic sector via a Bogoliubov-transformation circuit on quantum-simulation platforms^{[42][43]}. The present version reports classically evaluated quantum logic; execution on physical quantum hardware is identified as future work.

8. Declared Scope and Limitations

- The rapidity–mass relation uses gravitational particle production with integration over the mode spectrum; the dark-matter mass is an abundance-anchored value calibrated to the observed density.
- The field formulation of the dissipative sector is Markovian and treats modes as locally coupled; a non-Markovian extension with the full influence kernel remains future work.
- Quantum-simulation verification corresponds to classically evaluated quantum logic; execution on a physical quantum processor remains future work.
- The mirror sector has not been directly detected; its quantities are inferred by CPT conjugation.

The framework reinterprets information and measurement limits as properties of bipartite equilibrium. It does not claim to exceed the uncertainty principle or the laws of thermodynamics; it frames them as equilibrium cases, maintaining auditability throughout.

9. Formal Statement

QNUM states that the observable universe and its CPT-conjugate mirror sector form a closed, globally balanced bipartite system whose sector duality is realized as a hyperbolic rotation parameterized by a single cosmological rapidity. This geometry quantitatively links dark matter to a testable parameter, and the dissipative sector is expressed as a CPTP channel with a Lindblad field formulation anchored to calorimetric observables. The framework contains verified physics as a limiting case, conserves information under closed evolution, and satisfies the second law under open evolution, with each construction accompanied by an

auditability criterion and numerically validated against robust real and synthetic data. As the master model of the broader program, QNUM consolidates the equilibrium, information-economy, identity, confinement, and emergent-temporality pillars into one CPT-symmetric cosmological architecture.

Intellectual-Property Statement

Established physical results invoked here are prior art and are cited as such. The original contribution — the unified bipartite CPT-symmetric architecture and its operational core, including the quantum-geometric correction term, the closed-form inter-sector entropy and rapidity–mass relations, the explicit Kraus and Lindblad operators and decoherence profile, and the deterministic descriptor construction — is the subject of an intellectual-property filing (WIPO) and is withheld. Canonical identities reproduced here (such as the unit-hyperbola identity and the CPT equilibrium schematic) are public-domain physics and do not constitute disclosure of the protected core. Nothing in this preprint should be construed as a public disclosure sufficient to reconstruct, re-derive, reverse-engineer, or re-implement the protected formulation. The author retains all rights to the operational content.

References (Prior Art)

The physical results invoked by QNUM are established in the literature; the contribution of this work is the unified bipartite architecture and its closures over them. A representative selection of the primary sources is listed below.

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